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Environmental Education Program for Preschoolers

Kaela Gaylord
kgaylord@rollins.edu

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Psychology Department, Rollins College

Abstract

The present study looked at the effects of a three-week environmental education program on preschoolers aged from three to five years old. Attitudes about the environment were measured using a questionnaire adapted from The Children's Attitudes Towards the Environment - Preschool Version (Diamond & Musser, 1999), and knowledge was measured with an additional five questions about specific facts. Nine children from two different schools, Community School and Lab School, received the intervention of the environmental education program, and 15 children from both schools were in the control group. The main goal of this study was to see if participation in a brief, virtual environmental education program results in greater knowledge about the environment. Overall pre-test knowledge was statistically significantly associated with age ($r = .46$, $p = .03$), indicating that older children knew more at the pre-test than younger children. No statistically significant results were found between the control and intervention group for knowledge, and the attitudes portion of the questionnaire was not analyzed because of low reliability. The only statistically significant results were between Community School and Lab School, which was not the aim of the study, and with the small participant size it is unfair to make generalizations about the populations based on those findings.

Keywords: Environmental education, preschool, virtual program

Environmental Education Program for Preschoolers

Young children are curious about a variety of subjects, including learning about the outdoors and how different environmental processes occur. Nature is a core foundation that many educators use in order to teach about science, animals, plants, and ecological systems, and this incorporation has been found to increase children's environmental awareness to some extent (Hadzigeorgiou & Skoumios, 2013). These education programs can be formal or informal, and take on a variety of different curriculums that incorporate valuable subject material about the environment. However, there is little research on actual effects of environmental education programs on attitudes and knowledge about the environment in young children. Many case studies have occurred in different preschools around the world in order to analyze how environmental education programs are presented to preschool age children (Bailie, 2013; Jeronon et al., 2009; Myers, 2019). Common findings from such studies indicate that there are many inconsistencies in lessons taught and in teachers' perceptions of the efficacy of environmental education (Torquati, 2013). There is also no common measure used to analyze the efficacy of environmental education programs for preschool children on environmental attitudes and knowledge. The present study addressed these gaps in past research by examining the effects of a short-term developmentally appropriate, environmental education program on preschoolers' environmental attitudes and knowledge.

Formative experiences in family and educational contexts during early childhood can shape children's knowledge, beliefs and attitudes later in life (Kasser et al., 2002). For example, experiences with nature as a young child correlates strongly to caring about the environment as an adult. Adults who consider themselves to be environmentally conscious report having experiences in and about nature during their childhood (Broom, 2017). Early childhood is a critical time, and from three to five years old children begin to notice differences between

gender, and realize that the world is bigger than their immediate family. They start to have more independence, and experiences they have help grow their personality and beliefs (Lally & Valentine-French, 2019). Because of the enormous influence that all types of experiences have in these formative years, it is especially important to introduce the concept of environmental sustainability to children, whether that be through direct contact with the outdoors, lessons about nature, or abstractly discussing the protection of the natural world. Research finds that available resources within the classroom for science and other activities increases children's interest and interaction with those resources, and may have a lasting effect on their interests later in life (Sackes et al., 2011). Assessing what children know and believe about the environment is an important step in gaining more knowledge about what children already know, and how to most effectively increase their knowledge and influence their attitudes.

Everyday Influences of Environmental Literacy on Attitudes

Past research indicates that even before formal environmental education, children have preconceived notions of the environment (Palmer, 1994). These thoughts about the environment include a variety of topics, such as what happens to waste, and range greatly in factual accuracy (Palmer, 1994). Numerous environmentally specific factors contribute to children's concepts of the environment, including environmentally friendly behavior of children's parents (Diamond & Musser, 1999). Knowledge about the environment supports pro-environmental behavior (Braun et al., 2018). Additional factors, such as school, socioeconomic status, gender, and home life, influence environmental literacy. For example, past research indicates that adolescent females held more positive environmental views compared to male counterparts (Braun et al., 2018; Hampel et al., 1996). At a global scale, adults in wealthier nations with higher socioeconomic status had increased environmentally conscious attitudes (Pampel, 2014). A similar pattern of socioeconomic differences was found within adolescents in the US, such that those youth that

came from higher socioeconomic status backgrounds had higher levels of environmental consciousness (Hampel et al., 1996). In sum, past research indicates that increasing environmental education among people enhances their environmental attitudes, and there are many other outside factors that contribute to environmentally friendly behavior among different age groups, as well.

Specific Measures of Environmental Attitudes and Knowledge

Past research indicated that three factors increased environmentally friendly behavior among adults: a combination of good attitudes towards the environment, a feeling of connectedness towards the environment, and factual knowledge about the environment (Byrka et al., 2010; Mayer & Franz, 2004).

Measures of Environmental Attitudes

Environmental attitudes were studied through a variety of measures, including the New Ecological Paradigm Scale and the Connectedness Towards Nature Scale (Anderson, 2012; Mayer & Franz, 2004). Other scales, such as the Two Major Environmental Scale Values (2-MEV), analyze specific values -- the 2-MEV measures attitudes of preservation versus utilization, asking participants the extent to which they endorse statements such as “we need to clear forests in order to grow crops” (Sellman & Bogner, 2013). Much research focused on how adults perceive and behave towards the environment; this is not the case, however, with young children.

Scant research has examined young children’s environmental attitudes, and the studies that were conducted are not easily comparable, as there is not a commonly used scale that measures children’s environmental attitudes and knowledge (Leeming et al., 1995). One scale used among elementary and middle school children is the Children’s Environmental Attitudes and Knowledge Scale (CHEAKS; Walsh-Daneshmandi & MacLachlan, 2006). This scale has 36

questions for environmental attitudes, such as “To save energy, I would be willing to use dimmer light bulbs”, measured on a 5-point Likert scale. It also has 30 questions on environmental knowledge, such as “Burning coal for energy is a problem because it: a) releases carbon dioxide and other pollutants into the air. b) decreases needed acid rain. c) reduces the amount of ozone in the stratosphere. d) is too expensive. e) pollutes the water in aquifers.” This scale was created by Leeming at al. (1995), adapted from a scale used with adults that was developed by Maloney et al. (1975). However, as is, this scale is not developmentally appropriate for preschoolers; it is both too long and hard for younger children to understand. Because of the lack of appropriate measures for preschool children, Diamond and Musser (1999) adapted the Children’s Attitudes Towards the Environment Scale (CATES) to be appropriate for preschoolers. The original CATES was created by Musser and Malkus (1994) in order to measure environmental attitudes in grade school children, and includes 25 statements in which a child picks which statement is more like them, and subsequently if it is a lot like them or only a little like them.

The adapted CATES-Preschool Version is a moderately reliable, 15-question measure from CATES (Diamond & Musser, 1999). Each question gives a statement, such as “Some children sort their bottles and cans and recycle them but other children don’t sort their bottles and cans.” The child is then asked which one they feel like is more like them, and if they feel like they are a little or a lot like that child. In addition to testing the measure with 42 children, ranging in age from 40 months to 73 months old, Diamond and Musser measured environmental practices in homes of the children through parent surveys, in which parents were asked about their environmentally friendly practices. Children’s attitudes towards the environment and their environmental practices at home were strongly correlated, suggesting that the questionnaire accurately assessed children’s environmental attitudes. I adapted and utilized the CATES-Preschool Version in the present study.

Measures of Environmental Knowledge

Knowledge of the environment is much easier to measure because it is straightforward and factual. For preschool children, utilizing age-appropriate measures requires concrete examples along with relevant graphics to accompany questions (Witt & Kimple, 2008). Questions that are easy to understand and include simple language are the best, and most accurately measure what they are supposed to. In order to assess knowledge gained through lessons, the questions should be directly correlated to information presented. For example, Witt and Kimple (2008) taught preschoolers about metamorphosis, and one of the questions they asked to assess differences in children's knowledge before and after an environmental education program was "What kind of caterpillar is this?." Questions like this can determine levels of knowledge about different subjects. The researchers found that across all different subjects taught, preschoolers had an increase in knowledge related to the subjects that were taught.

Environmental Education Programs

While environmental education is a subject of interest among many educators and conservationists, standardized environmental programs developed for children are not available for concise and definitive use. There is much available data on effects of nature on children, such as it can help increase motor function, relieve stress, and increase positive affect (Bailie, 2013; Fjørtoft, 2001; Fuegen & Breitenbecher, 2018; Myers, 2019). However, there is no universally accepted environmental education program that has been measured and analyzed in terms of its impact on young children's environmental attitudes, knowledge, and behavior.

In older adults, research has examined the effectiveness of short environmental education programs. Sellman and Bogner (2013) measured how environmental attitudes of high schoolers in Germany changed after a one-day environmental education program. Attitudes of preservation and utilization were measured directly before and after the program, using the 2-MEV, and then

again four to six weeks later. Directly after this research was conducted, attitudes of preservation (the idea that the protection of nature is important) had increased, and utilization (the idea that humans use nature simply for its resources) had decreased. However, these changes were not retained long term, and Sellman and Bogner theorized that longer environmental education programs along with increased experiences with nature would result in longer term changes in attitudes about the environment.

In research with younger children, storytelling has been found to be an effective method of communicating important ecological information in addition to other hands-on activities (Hadzigeorgiou, 2001). Hadzigeorgiou et al. (2011) analyzed the effect of storytelling versus more traditional lesson teaching in young children. Both types of lessons incorporated important information of the ecological processes that trees undergo, but after testing the retention of factual knowledge in the preschoolers, the group that had received the knowledge in the form of storytelling had significantly better recall of the information that was presented to them. Mahasneh et al. (2017) utilized storytelling to teach about the importance of water, energy, and littering, and measured knowledge and subsequent behavior change in the children immediately before and immediately after stories were read. The researchers found that knowledge significantly increased after the stories were read, and that the majority of parents reported their children's behaviors changing to become more environmentally friendly after exposure to the stories. Storytelling is a very important part of education, as it engages children in a narrative that has the capability of keeping their attention, using relatable characters and topics, and incorporating appropriate visual stimulation (Hadzigeorgiou, 2001).

To adapt to the demands of the current global pandemic of COVID-19, our research focused on lessons that could be taught virtually, and did not include hands-on activities that are effective in promoting learning in young children (Ekwueme et al., 2015). Still, we utilized an

engaging storytelling style to engage children in brief, virtual lessons about environmental subjects.

The Present Study

Environmental and science education is critical in the preschool population, and the present study measures attitudes and knowledge that preschool children have about the environment before and after six video lessons of specific environmental issues. The purpose of this study was to better understand how children learn about the environment, and if video lessons based on storytelling could increase young children's specific knowledge and general attitudes about the environment. Past information on the subject of environmental education showed that there are many different ways to present information and measure its effect on individuals' behaviors, knowledge, and attitudes. However, in the preschool population it seems especially important to understand the impact of storytelling on knowledge retention, and the idea that greater environmental knowledge can increase environmentally friendly attitudes. The aim of the present research was to analyze the extent to which a short-term environmental education program changed young children's attitudes and knowledge about the environment. Based on the research reviewed, I hypothesized that preschool children participating in a short-term virtual environmental education program would endorse more environmentally friendly attitudes and have more environmental knowledge compared to preschoolers in a control group.

Method

Participants

The present study included 24 participants between the ages of 3 to 5 years old (M_{age} = 50.62 months; SD_{age} = 7.00 months). Seven participants were from Community School (M_{CS} = 51.14 months; SD_{CS} = 7.08 months), a community school located in the southeastern US, and 17

were from Lab School (M_{LS} = 50.41 months; SD_{LS} = 7.17 months), a child development center located on the campus of a small liberal arts college in the southeastern US. Community School represents primarily people of color and low income families. Lab School primarily represents an ethnically diverse group of middle to upper-middle class, and approximately 65% are children of faculty/staff and 35% are from the local community. The control group consisted of four children from Community School and 11 children from Lab School, and the experimental group consisted of three children from Community School and six children from Lab School.

Design

The design of this study was developed based on a comprehensive literature review of existing environmental education programs for children. Our environmental education program was based on storytelling because of its efficacy in relaying factual knowledge (Hadzigeorgiou, 2001). The program was three weeks long and had two roughly ten-min lessons per week. Each lesson was a recorded reading of one of five different subjects: recycling, trees, water, bees, and littering, followed by a final lesson of review (see Appendix A for links to program lessons). Lesson subjects were based on different ecological aspects of the environment, and combined natural and man-made concepts. Books were found on each of the subjects, and points of interest were emphasized within the reading.

At Community School, children in the older class received the environmental education program, while children in the younger class were the control group. At Lab School, the format of the classes allowed for children who were a mix of ages to be in the intervention/no-intervention group. One small group was randomly chosen to receive the intervention, and the other group was chosen to be the control.

Environmental Attitudes

Approximately one month before the start of the environmental education program and one month after the conclusion of the environmental education program, the children were asked 11 questions adapted from Diamond and Musser's (1999) Children's Attitudes Towards the Environment - Preschool Version (CATES-PV) and five questions that measured specific knowledge from the lessons (see Appendix B for the full list of questions, and sample questionnaire). These 16 questions were asked one month before and one month after in order to measure longevity effects of the environmental education program. Research on environmental education programs commonly finds that there is an increase of knowledge immediately after environmental education programs, but that immediate post-program effects may not persist more than a few months into the future (Sellman & Bogner, 2013).

Questions from the CATES-PV followed the format of "Some children are like this, but other children are like this. Which one do you feel is more like you? Is that a lot like you or a little like you?". All of the questions were reformatted to say "children", rather than "girl" or "boy", to be gender inclusive. Four of the original questions from the CATES-PV were not included in our questionnaire because of their inappropriateness for the present research. These questions were:

1. Some girls like to feed the birds but other girls don't like to feed the birds.
2. Some girls like to live where there are lots of people but other girls like to live where there are lots of plants or animals.
3. Some girls never touch or catch animals they find outside but other girls like to touch or catch wild animals.
4. Some girls like to ride with other girls even if it is a little crowded but other girls don't like to be crowded in the car.

Question one and question three were deemed inappropriate because in present society people are commonly told to not feed or interact with wild animals. This question would not properly measure environmental attitudes because of that. Question two was deemed inappropriate because the children who represent this study all live in urban settings, and so have little or no experience living rurally. Question four was deemed inappropriate because of the mixed messaging that COVID-19 may bring to carpooling in general. An additional question "some girls think that wild animals need protection but other girls think that we should be able to hunt and kill all wild animals" was changed to "some children think that wild animals need protection but other children think that we should put houses on land where wild animals live." During presentation of questions, pictures were paired with each statement in order for children to better understand the questions. The researcher asking the questions pointed to each correlating picture as they were reading the statements. The original questions from the CATES-PV were paired with line drawings, but unfortunately these line drawings were not saved. Our questionnaire paired questions with real life photographs found from web searches.

Environmental Knowledge

An additional five questions were asked that did not include photographs. These questions were created to measure participants' factual knowledge about specific environmental subjects, and included one question for each lesson. An example of questions asked were "What is an item you can recycle?" and "Why are bees important?". Children's recorded responses to the knowledge questions were transcribed verbatim. We developed a coding scheme to measure the complexity of children's open-ended responses to the five knowledge questions using an iterative approach in which two researchers grouped children's responses to "Why are bees important?" and discussed similarities and differences between the groupings. We decided on a 4-point coding scheme, in which 0 was assigned to incorrect or non- answers, 1 was an answer

including a semi-relevant word or phrase, 2 being an almost correct answer, and 3 being a correct answer (see Appendix C for full coding key to knowledge answers). To examine the feasibility of this coding scheme, we applied it to children's responses to "What is one reason that trees are important?". Final points of confusion were discussed between researchers, and the coding scheme and final definitions were revised slightly based on the discussion. Subsequently, a third researcher (who was not involved in the development of the coding scheme) coded children's responses to the tree questions based on the revised coding scheme in order to test for reliability. Inter-observer agreement between the two researchers measured by Cohen's kappa was good ($\kappa = .88$). The two discrepancies were discussed and resolved. After this, the primary researcher coded the remaining responses to all of the knowledge questions.

The entire program was developed in order to be compliant with CDC safety standards and guidelines for the COVID-19 pandemic. For this reason, the environmental education program was made to be entirely virtual, with the exception of the pre- and post-test. While research suggests that hands-on, in-person learning is ideal for young children (Ekwueme et al., 2015), the global pandemic has made it necessary to adapt and develop curricula that is accessible virtually; while virtual preschool content may be much different than in-person content and present unique hardships for educating young children, it may still offer viable and useful educational tools.

Materials

Materials used for this research included phone and computer cameras in order to capture video recordings of the book lessons. Videos were edited using iMovie, and uploaded to YouTube for easy access and viewing. The adapted version of the CATES-PV was used in our questionnaire along with five additional specific knowledge questions. Each child had their own printed out script with pictures, in which their answers were marked on the paper. When asking

the children the questionnaire, each conversation was audio recorded using a recording device in order to be able to accurately transcribe answers.

Procedure

The study was approved by the college's Institutional Review Board, and parents provided consent for participating children to take part in the study. During the pre-test and post-test, a researcher independently pulled children aside to an empty room for a period of 10 to 15 min. Before the questions were asked, the researcher turned the audio recording device on. Assent to ask questions was confirmed, and then the researcher asked the children all of the questions in the same order. The researcher read questions from a script, as to make sure that all questions were asked in the same way. At Community School, a trained researcher asked children the questions. The pre-test and the post-test questions were asked by different researchers, neither with whom the children were familiar. At Lab School, the preschool director of research asked children the questions. The researchers asked the questions to all the children with informed consent from parents approximately one month before the start of the environmental education program, and again approximately one month after the end of the environmental education program. The children in the control group were asked the same questions during the same time periods, but did not receive the environmental education program inbetween. Instead, they received the environmental education program after the conclusion of the research, in order to still gain access to the lessons.

The children in the experimental group at Community School received the environmental education program on Tuesdays and Thursdays before snack. Due to inability to separate the children based on an even distribution of age, we made the pragmatic decision to assign the older children to the environmental education program condition while the younger children were in the control group. The children viewed a Webex room in which they were presented with the

ten-minute recorded lesson; I shared my screen, and played the pre-recorded lessons from my computer for their viewing. For all lessons they sat together. At Lab School, the recorded video lessons were presented during small group, where ages are mixed. These lessons were also presented on Tuesdays and Thursdays. For both groups, lessons occurred twice a week for three weeks.

Each child was assigned a random ID number in order to protect participants' confidentiality. All scored and coded data were imported into SPSS and analyzed to address our primary research questions regarding the extent to which a short-term environmental education program could change young children's attitudes and knowledge about the environment.

The Children's Attitudes Towards the Environment Scale (CATES) was deemed unreliable, as the pre-test had a Cronbach's alpha score of .12. The post-tests for the CATES scale also had an unreliable score, with a Cronbach's alpha of .40. This scale was not analyzed further, as this low reliability score is indicative that the preschool participants did not understand this measure, and that the measure was not appropriate for the data it was trying to capture. The five knowledge questions, which included "What is an item that you can recycle?", "Why are bees important?", "What is one reason that trees are important?", "What is one way that you can save water?", and "Why is it bad to litter?" had a high interrater reliability, with a Kappa score of .88 for the question "What is one reason that trees are important?". This scale was analyzed further for differences between the pre- and post-test, intervention versus no intervention, age, and Community School versus Lab School scores.

Results

The present study aimed to analyze the extent to which a short-term environmental education program changed young children's attitudes and knowledge about the environment. Because the CATES was an unreliable measure at pre- and post-test, indicating that the preschool

participants did not understand this measure, I did not include this measure of environmental attitudes in our primary analyses.

Associations Among Pre/Post-Test Knowledge and Age

I first conducted a series of Pearson's *r* correlations to examine associations among children's pre- and post-test knowledge for each of the five environmental topics and their age. Overall pre-test knowledge was statistically significantly associated with overall post-test knowledge ($r = .68$, $p < .01$), indicating that children who knew more/less at the pre-test also knew more/less at the post-test (see Table 1). Overall pre-test knowledge was also statistically significantly associated with age ($r = .46$, $p = .03$), indicating that older children knew more at the pre-test than younger children. With specific environmental knowledge questions, only the pre-test litter question was statistically significantly correlated with age ($r = .42$, $p = .05$). See Table 1 for correlations.

Does Participation in an Environmental Program Result in Greater Knowledge about the Environment?

An independent samples *t*-test indicated that children from the two schools ($M_{\text{CommunitySchool}} = 0.94$, $SD_{\text{CommunitySchool}} = 0.36$; $M_{\text{LabSchool}} = 1.17$, $SD_{\text{LabSchool}} = 0.59$) did not statistically differ from each other in pre-test knowledge, $t(21) = -.861$, $p = .28$. However, they did differ in several specific knowledge measures at the pre-test, including recycling, ($t(21) = -1.64$, $p < .01$), bees, ($t(21) = -2.90$, $p < .01$), and littering ($t(21) = -1.32$, $p < .01$). This pattern of results indicated that several of the knowledge responses for participants at Lab School ($M =$) were higher than responses for participants at Community School ($M =$) at the pre-test. The two school samples differed by age in the intervention group ($t(7) = 2.90$, $p < .01$), such that Community School ($M = 58.33$) were older than Lab School ($M = 52.33$). Given the small sample sizes of the two schools, the age differences between the intervention group, and the non-statistically significant

differences in total pre-test knowledge, I combined all participants to increase statistical power in examining my primary research question regarding the extent to which a short-term environmental education program increased young children's knowledge about the environment.

I ran an independent samples *t*-test to examine mean differences in age in the control group versus the intervention group. The control group ($M_{Control}$ = 48.40, $SD_{Control}$ = 7.54)($M_{Intervention}$ = 54.33, $SD_{Intervention}$ = 4.06) was younger than the experimental group ($M_{Intervention}$ = 54.33, $SD_{Intervention}$ = 4.06) by approximately 5 months, but this age difference was not statistically significant, $t(22) = -2.17$, $p = .31$. The intervention versus control groups varied in age because of the fact that classes could not be mixed at Community School, meaning the older children were the ones that received that intervention. Overall age between Community School and Lab School was very similar (M_{CS} = 51.14, SD_{CS} = 7.08; M_{LS} = 50.41, SD_{LS} = 7.17).

To analyze the effect of the environmental education program on the children's knowledge about the environment, I conducted a series of 2 X 2 mixed model ANCOVAs, where Intervention Condition was the between-subjects factor (Experimental v. Control) and Time (Pre/Post) was the within-subjects factor, and age was included as a covariate to account for the statistically significant association between age and pre-test knowledge. Dependent variables included Overall Knowledge and specific Environmental Knowledge (Recycle, Bees, Trees, Water, and Litter). A 2 (Intervention) x 2 (Time) mixed model ANCOVA revealed that the main effect for Intervention was not statistically significant after controlling for age, $F(1, 20) = .192$, $p = .67$. Thus, there was no overall difference in mean environmental knowledge for the intervention group ($M = 1.40$) compared to the control group ($M = 1.27$). The main effect for time was not statistically significant, $F(1, 20) = .12$, $p = .73$, indicating that there was no statistically significant difference between pre- ($M = 1.11$) and post-test ($M = 1.56$) environmental knowledge. Further, the Intervention X Time interaction was not statistically

significant, indicating that the change from pre- to post-test knowledge did not statistically differ for the Intervention and Control groups (see Figure 2). The pattern of results for the specific environmental knowledge topics was similar, indicating participants in the Intervention group did not statistically differ in their change from pre- to post-test knowledge compared to the Control group (see Figures 2 - 7).

Descriptive Statistics for Pre- and Post-Test Knowledge for Participants in the Experimental Group

Frequencies of scores on children's responses to the knowledge questions varied between pre- and post-tests. While there were no statistically significant differences between pre- and post-test responses for the intervention group, descriptive results indicated that after the intervention there was a higher percentage of responses scored as correct at post-test compared to pre-test for all five subjects. See Figure 1 for a complete chart of percentages for the intervention group. The question that had the biggest difference between the pretest and the posttest was the recycling question, with an increase of scores of three by roughly 25%. The only anomalies in the data were observed for the bee and the tree knowledge questions, where there was a small increase in answers rated as zero, fewer answers rated as one or two, and more rated as three. Overall, raw data indicated that there was a higher frequency of scores of three after the intervention than before the intervention for all five environmental knowledge questions.

Do Community School and Lab School Differ in Results From the Environmental Education Program?

One month after the intervention occurred, overall knowledge scores for Community School and Lab School differed significantly, $t(18.79) = -4.71$, $p < .001$. Post-test answers in Community School ($M = 0.51$) were lower than post-test answers in Lab School ($M = 1.87$), with Community School showing a decrease in scores from pre-test ($M = 0.94$) to post-test. In

addition, at the pre-test there were statistically significant differences between Lab School and Community School for responses to recycling, $t(20.61) = -2.57$, $p < .05$; $M_{CS} = 0.17$, $SD_{CS} = 0.41$, $M_{LS} = 1.18$, $SD_{LS} = 1.47$; and bees, $t(16) = -4.94$, $p < .001$; $M_{CS} = 0.00$, $SD_{CS} = 0.00$, $M_{LS} = 1.59$, $SD_{LS} = 1.33$. At the post-test there were statistically significant differences between Community School and Lab School for responses to bees, $t(16) = -5.69$, $p < .001$; $M_{CS} = 0.00$, $SD_{CS} = 0.00$, $M_{LS} = 1.88$, $SD_{LS} = 1.36$; littering, $t(18.81) = -3.63$, $p < .01$; $M_{CS} = 0.29$, $SD_{CS} = 0.76$, $M_{LS} = 1.82$, $SD_{LS} = 1.29$; and overall knowledge, $t(18.79) = -4.71$, $p < .001$; $M_{CS} = 0.51$, $SD_{CS} = 0.51$, $M_{LS} = 1.87$, $SD_{LS} = 0.87$. This pattern of results is similar to differences between the two schools at the pre-test. Overall, results indicated that participants from Community School scored lower on several of the pre- and post-test knowledge measures compared to participants from Lab School.

Discussion

In the present study, I examined the effects that a short term, virtual environmental education program had on both the attitudes and knowledge of preschool aged children. Findings for the attitudes portion of the test were unreliable; results from the knowledge section indicated that participants in the intervention group did not demonstrate significantly greater knowledge from pre- to post-test compared to participants in the control group. However, descriptive, raw scores from this small sample suggest that children in the intervention group may have acquired new knowledge as a result of their participation in the environmental education program. Power in our statistical tests was lacking because of the small sample size. With a greater number of children participating, it is likely that we would have found statistically significant results for increases in knowledge after the intervention of the environmental education program.

Associations Among Pre/Post-Test Knowledge and Age

Older children had more environmental knowledge at the pre-test. Developmentally this makes sense, because as children get older, they gain more experience with and knowledge about

the natural world (Riggins & Rollins, 2015). We included age as a covariate in our statistical analysis because of this and because the intervention group was statistically significantly older than the control group. As previously mentioned, the intervention group was older than the control group because at Community School the control and intervention group had to be separated by class, and therefore by age. Preschool is a critical time in children's development, as they start to acquire knowledge and facts about the environment through engagement with and exploration in nature.

Does Participation in a Brief, Virtual Environmental Program Result in Greater Knowledge about the Environment?

Results from the ANCOVA statistical analyses suggested that there were no statistically significant differences between the control and intervention group in change in overall knowledge or specific environmental knowledge. This fits with past research, as a study by Sellman and Bogner (2013) found that as time after an environmental education program went on, knowledge related to the environmental education program was forgotten by people that had participated. Our post-test was conducted about a month after the environmental education program, and so it is likely that children forgot information related to the lessons that they viewed. Additionally, it is a short-term environmental education program and also virtual, both of which have been found to be not as effective as a long term, in person program (Zacharia et al., 2012). Because of these factors, it might have been difficult to increase preschoolers' environmental knowledge.

Descriptive Statistics for Pre- and Post-Test Knowledge

While there were no statistically significant findings, all five of the knowledge questions had increased ratings for correct answers in the intervention group after the implementation of the environmental education program. The response that had the greatest amount of change was

the recycling question. In the intervention group, six children answered the question wrong and three answered the question correctly during the pre-test, while in the post-test two answered incorrectly, one answered almost correctly, and the remaining six answered correctly. This could have been because recycling is something that is most prominent in children's lives, and so after a lesson on it they were continuously exposed to the idea of recycling. The question that had the least amount of change between pre-test and post-test was the bee question. In the intervention group, three children answered correctly before the environmental education program and four answered correctly after the environmental education program. This could have been because many of the children seemed afraid of bees, and so answered the question with a statement such as "bees sting".

A close examination of children's verbatim responses to the environmental knowledge questions provides an interesting window to children's environmental understandings and suggests that at least some children had a more sophisticated understanding of the specific topics after the program. For example, one child in the intervention group first answered the question "Why is it bad to litter?" with ""I don't know. There's some stuff I don't know about", and then after the environmental education program the child answered the same question with, "Some animals can get sick and then need to go to the doctor". In response to the question "Why are trees important?", one child first answered the question with the statement "You can't shake them cause they'll fall down", and after the environmental education program answered with "Because they grow stuff! Like apples and acorns". These answers indicate more in-depth knowledge about the particular topic after participation in the environmental education program.

These changes in answers indicate that the environmental education program is viable to test again with some changes in format and scales. While the results were not statistically significant, the low statistical power that resulted from the small sample reduced the chance of

detecting a true effect on knowledge as a result of participation in the environmental education program. Other reasons for these results could be because of the short term and online nature of the environmental education program, which could have made it harder for participating children to pay attention and remember what they had watched. Research indicates that hands-on activities contribute more to active engagement and retention of knowledge (Walan, 2019) than virtual programming and lessons do.

Critiques of the Environmental Attitudes Scale Used in our Study

The Children's Attitudes Towards the Environment for Preschoolers yielded very low reliability, and so we did not spend much time discussing the possible implications of the results of this scale. However, the low reliability tells researchers that this kind of scale is not useful *as is* to use with young children. We do know that young children have ideas and perceptions about the environment (Palmer, 1994), and that because of this an accurate scale should be developed and tested in order to understand more about how cognition regarding the environment works in young children.

There are many reasons why the present version of the CATES scale did not work in our research. One reason is that the ideas presented in the questions may have been too complicated for three- and four-year-olds to grasp, and so they just selected response options that appealed to them in the moment. A second possibility for the low reliability is that instead of listening to the questions, the children attended primarily on the photos presented to them that accompanied each question, and chose answers based on the pictures. One researcher noticed that a few of the children from School 2 seemed to choose photos that had a red x through them or vice versa. The length of the questionnaire might have been an issue as well, as there were eleven questions for the attitudes section followed by five knowledge questions. Some children became distracted during the pre-test/post-test, and had to be asked questions multiple times.

A suggestion that the head preschool research director had was to re-enact some of the most relevant questions that the CATES questionnaire included, so that the children could have a hands-on representation of the question. For example, there is a question that asks the children if they leave the light on or turn off the light when they leave a room: perhaps the child could be asked to show the researcher what they do with the light when they leave the room. Other, more general suggestions would be to cut the length of the questionnaire, and only include questions that are directly relevant to a preschooler's life. Some of the questions that we included were very general, and so might have been difficult for preschoolers to understand. In the future, more specific questions might be useful.

Accurately Measuring Preschooler's Environmental Attitudes

The scale that we chose to measure environmental attitudes, the Children's Attitudes Towards the Environment Scale, was unreliable and did not adequately assess preschooler's environmental attitudes in the present study, yet past research indicates that young children do have thoughts and attitudes about the environment (Palmer, 1994). This poses an interesting question of how to measure attitudes of children accurately.

Creating a more developmentally-appropriate, experiential assessment of environmental attitudes may advance the field of environmental education among younger children. This is especially important, as experiences and knowledge gained during early childhood sets up a critical foundation for future thoughts and behaviors in a wide variety of ways (Erturk Kara, Aydos, & Aydin, 2015). This is applicable to future action towards environmental sustainability. Being able to accurately measure children's attitudes towards the environment would allow educators and researchers to better understand the best way to teach about the environment to maximize the impact that resources teachers use have.

The Role of Virtual Learning in Early Childhood Education

The pandemic has caused the education system within the United States to change from in person learning to virtual learning, and has illuminated that there are disparities in accessibility to resources that children can use while they are at home. These effects are amplified by income levels and other factors, such as access to computers, internet, quiet home space, etc. (Kim, 2020). Specifically in early childhood, it is critical to have hands-on, interactive instruction in order for children to fully learn about how they can manipulate their environment. Physicality is an important tool for learning (Zacharia et al., 2012), which is something that the current study could not accomplish due to COVID-19. Overall, there are many issues that arise when learning becomes 100% virtual, in terms of practical application and access to materials, among others. However, there is a way in which technology could be incorporated into schools in order to build off of lessons that are already being taught, and enhance what children are learning. Incorporating more technology into schools could increase the efficacy of lessons that are already being taught (Al-Bataineh et al., 2016). Having a wide variety of tools that teachers can use in order to motivate and teach students is important, and technology poses an excellent opportunity to reinvigorate that academic scene.

The present study demonstrates that a brief, engaging, story-based environmental education program can be implemented easily by teachers and enjoyed by young children. The environmental education program can have a wide variety of stories, and anyone can be filmed reading the stories (i.e. interested parents, teachers, and/or volunteers). Future research examining such programs with a larger sample of preschool-aged children may yield changes in environmental knowledge, attitudes, and behaviors.

Limitations and Future Directions of the Environmental Education Program

Community-based research with young children in early educational contexts can present challenges, as the experimental design must be able to adapt to different situations that were not

originally accounted for. The present study was no exception, and many adaptations had to be made in the moment in order to accommodate different situations that were unexpected. In Community School, the environmental education program was first presented to all of the children at the same time, viewed from one screen. However, after this attempt it was clear that having all of the children at Community School sit together would not work, as they were constantly distracting each other. The following lesson, each child sat at their own device to independently watch the video lessons. This differed from Lab School, where the children sat in their mixed age small groups and watched the video lessons together with their teachers. The demographic differences between the two schools likely contributed to the variation of responses in environmental knowledge between the two populations.

These extraneous variables that occur in real life could have shifted some of the results of this study, and so if done again it would be critical to have a larger control and experimental group. Additionally, it would have been useful to have the same researcher observe the implementation of the environmental education program in order to ensure that all lessons were as similar to each other as possible. In the present study, there was no objective bystander that observed lessons at both schools, and so it was simply an educated guess that lessons occurred similarly between both preschools.

In terms of the education program itself, many changes could be made to the format of the lessons. The lessons in the current study were pre-recorded readings from different books, and were not accompanied by any hands-on activities or other lessons. During the creation of this study it was important that the environmental education program was as virtual as possible in order to be compliant with CDC safety guidelines for the COVID-19 pandemic. However, interactive and hands-on lessons could be combined with the storytelling lessons in order to increase gains in knowledge (Walan, 2019). Hands-on activities are often more memorable to

children, and so in order to maximize benefits from an environmental education program incorporating hands-on and experiential aspects of learning could be critical (Cheng et al., 2019).

The Big Picture: Importance of Environmental Education at Young Age

Historically, environmental education has long been behind other subjects to gain momentum in schools (Saylan, & Blumstein, 2011). However, recently climate science, earth science, and other environmental subjects have been gaining traction in the current atmosphere of environmental duress. It is becoming more and more critical to set up future generations for success, with a solid background of factual scientific knowledge. However, almost more importantly we need to imbue future generations with the right attitudes towards nature and the environment, and inspire them to intrinsically care about the welfare of the natural world. In order to do this, there needs to be a better understanding of how childhood experiences with and about nature influence later perception and environmental activism in both individual people and generational cohorts. A critical component to understanding and cultivating concern about the environment is the development of better scales to use with young children to measure environmental attitudes and perceptions. In addition, it is important to conduct longitudinal studies in order to look at the effects of life events and exposure to nature as a key tool to increasing environmental awareness and activism. These tools need to be combined with existing teaching strategies that have been shown to be effective, such as hands-on, experiential learning. Additionally, it could also be important to look at the efficacy of incorporating different aspects of virtual learning to increase the influence of activities already taking place in schools. COVID-19 has shown that the landscape of learning can change instantaneously, and having the ability to smoothly transition between in-person and virtual learning could be highly beneficial, even for young children.

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Table 1

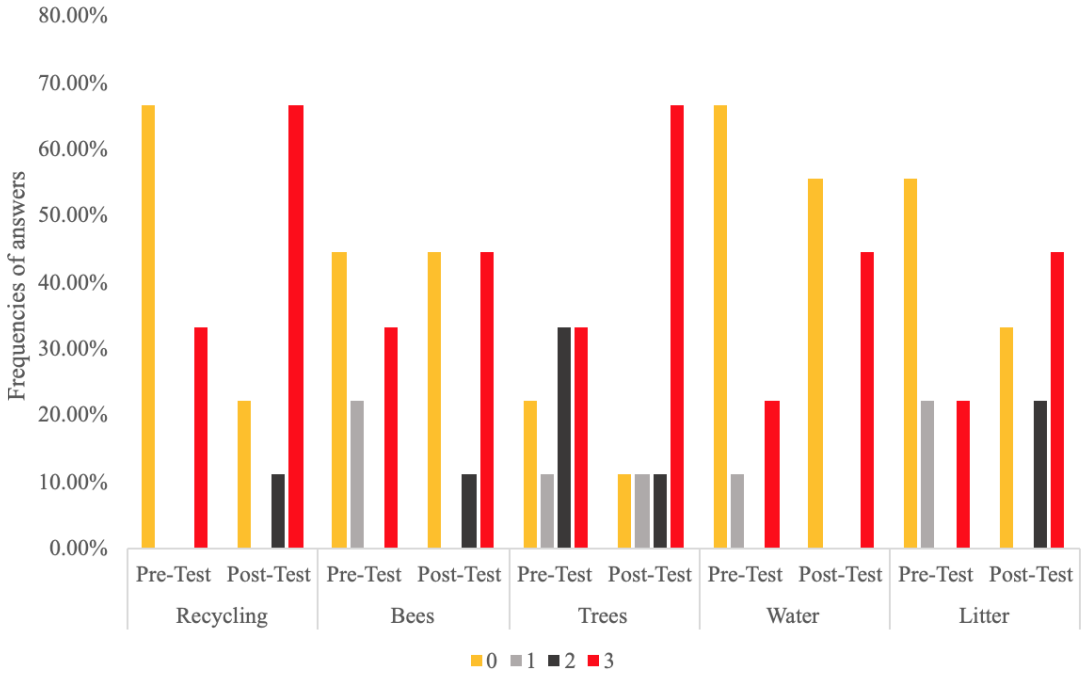
Correlations Among Age and Pre-Test/Post-Test Knowledge For Intervention Group

	Age Months	Pre Know Total	Post Know Total	PRE: Recycle	PRE: Bees	PRE: Trees	PRE: Water	PRE: Litter	POST: Recycle	POST: Bees	POST: Trees	POST: Water	POST: Litter	M (SD)
Age Months	1													50.62 (7.00)
Pre KnowTotal	.46*	1												1.11 (0.54)
Post KnowTotal	.32	.68**	1											1.47 (1.00)
PRE: Recycle	.28	.53**	.32	1										0.91 (1.34)
PRE:Bees	.11	.70**	.67**	.36	1									1.17 (1.34)
PRE:Trees	.13	.42*	.17	-.07	.14	1								1.35 (1.15)
PRE:Water	.24	.30	.34	-.04	-.10	-.05	1							0.83 (1.15)
PRE:Litter	.42*	.78**	.68**	.28	.74**	.17	.05	1						0.87 (1.18)
POST: Recycle	.06	.27	.76**	.32	.35	-.02	.11	.39	1					1.87 (1.39)
POST:Bees	.18	.52*	.75**	.3	.77**	.08	.10	.49*	.46*	1				1.33 (1.43)
POST:Trees	.32	.60**	.77**	.25	.51*	.27	.27	.50*	.51*	.53**	1			1.50 (1.38)
POST:Water	.30	.71**	.57**	.01	.4	.46*	.47*	.62**	.18	.21	.42*	1		1.29 (1.40)
POST:Litter	.38	.29	.73**	.30	.37	-.22	.26	.41	.61**	.50*	.31	.24	1	1.37 (1.34)

* Correlation is significant at the .05 level (2-tailed).
** Correlation is significant at the .01 level (2-tailed).

Figure 1

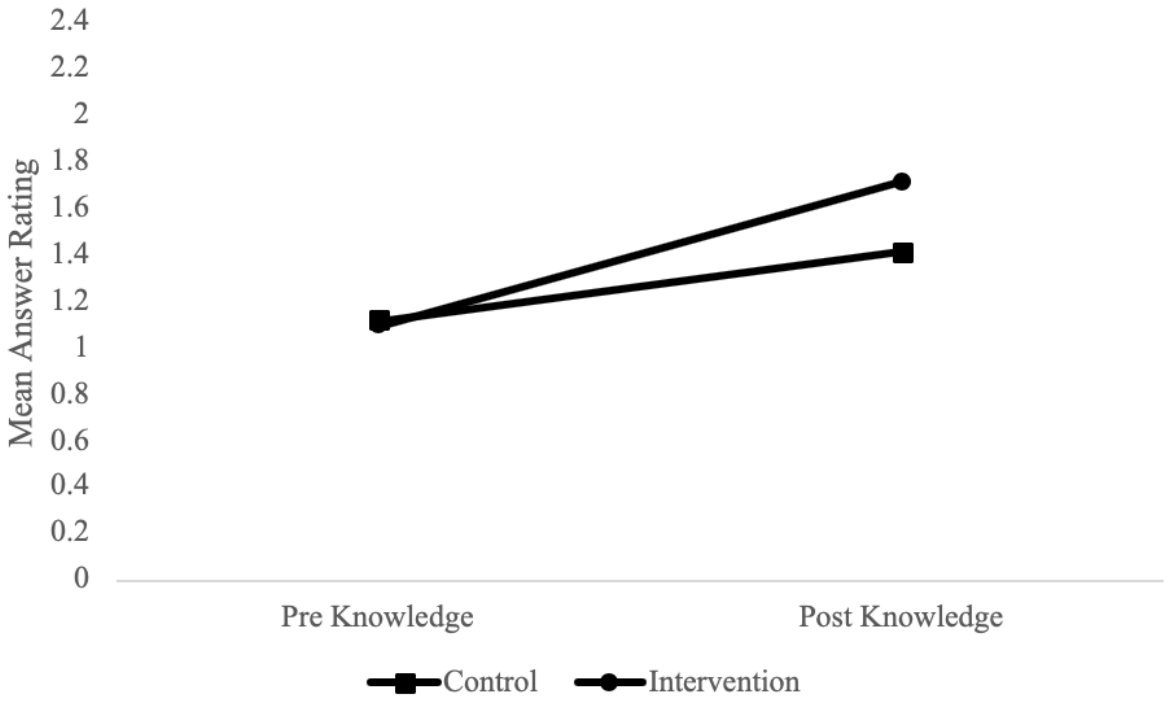
Percentages of pre-test and post-test responses to knowledge questions for the intervention group



Note. For the experimental group in all five questions the descriptive results show that there were fewer zeros and more threes in the post-test than the pre-test, indicating a not-statistically significant increase in knowledge.

Figure 2

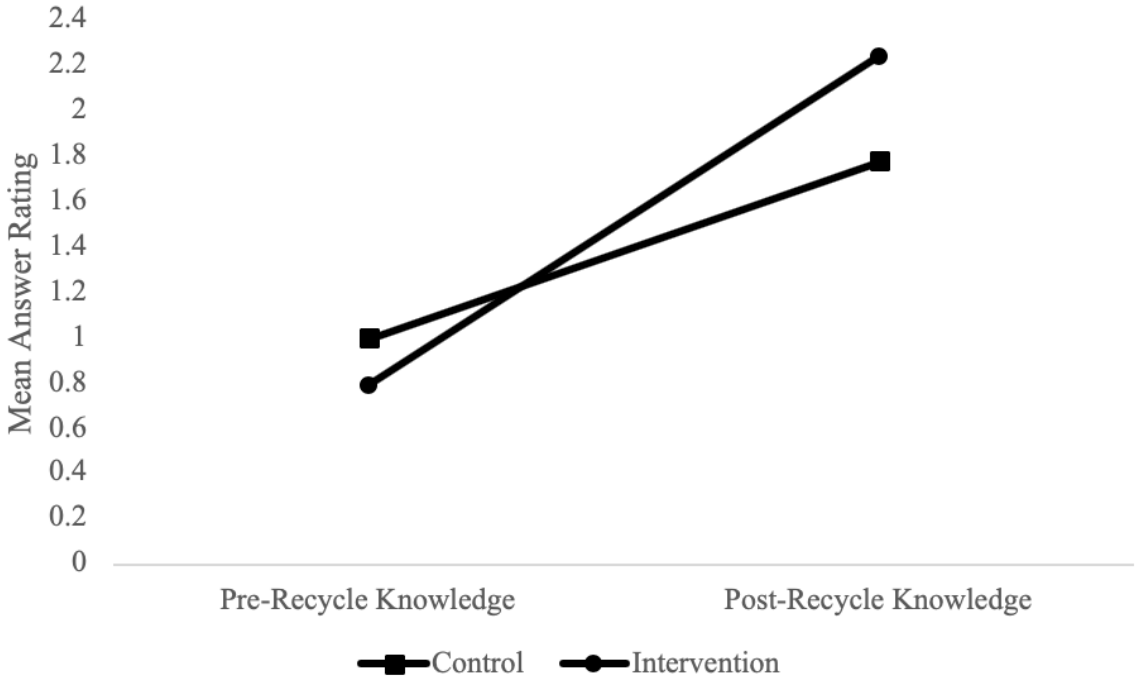
Mixed model ANCOVA for overall knowledge



Note. Pre-test and post-test means with regards to overall pre- and posttest knowledge. The figures represent knowledge means for a typical 50.62 month old child. There was no significant main effect for intervention, $F(1, 20) = .19$, $p = .67$, no significant main effect of time, $F(1, 20) = .12$, $p = .74$, and no significant interaction of intervention x time $F(1, 20) = .86$, $p = .36$.

Figure 3

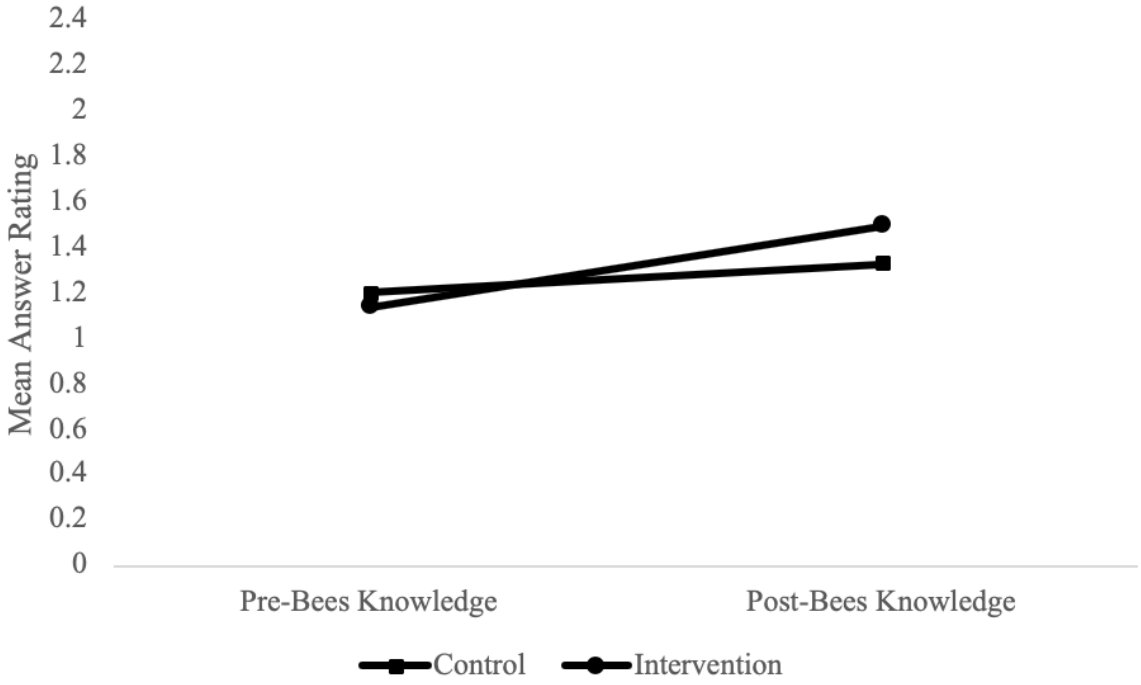
Mixed model ANCOVA for recycling question



Note. Pre-test and post-test means with regards to age for the question "What is an item that you can recycle?". The figures represent knowledge means for a typical 50.62 month old child. There was no significant main effect for intervention, $F(1, 20) = .05$, $p = .82$, no significant main effect of time, $F(1, 20) = 2.52$, $p = .13$, and no significant interaction of intervention x time $F(1, 20) = .80$, $p = .38$.

Figure 4

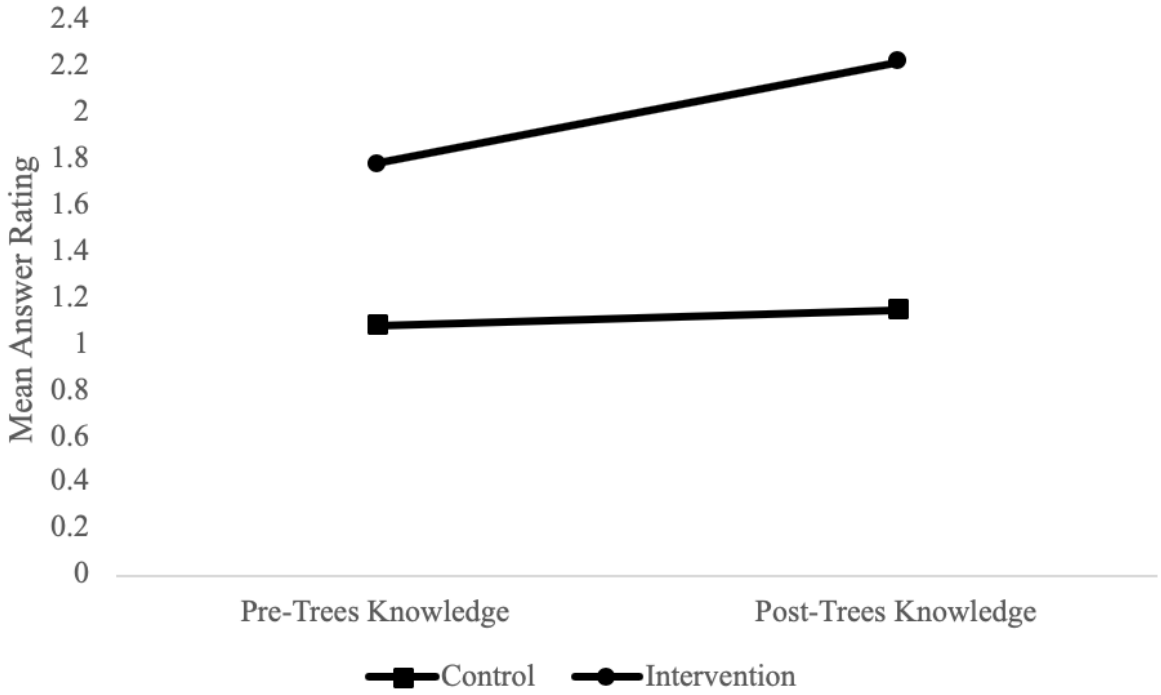
Mixed model ANCOVA for bee question



Note. Pre-test and post-test means with regards to age for the question "Why are bees important?". The figures represent knowledge means for a typical 50.62 month old child. There was no significant main effect for intervention, $F(1, 20) = .01$, $p = .93$, no significant main effect of time, $F(1, 20) = .12$, $p = .75$, and no significant interaction of intervention x time $F(1, 20) = .24$, $p = .63$.

Figure 5

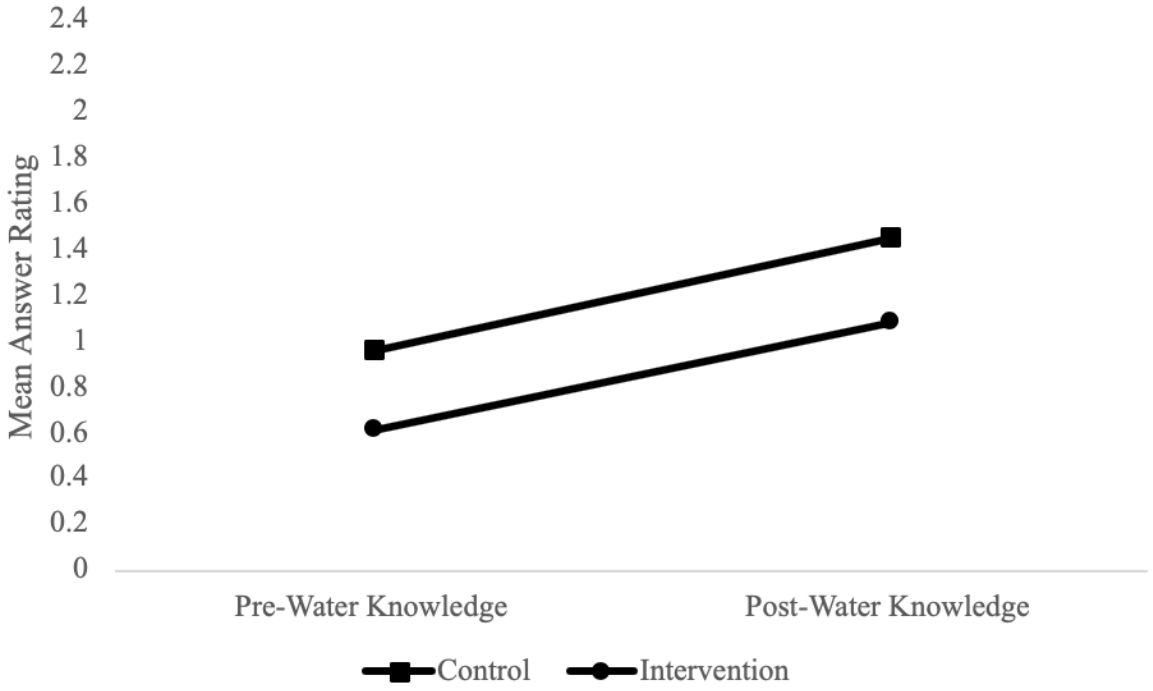
Mixed model ANCOVA for tree question



Note. Pre-test and post-test means with regards to age for the question "What is one reason trees are important?". The figures represent knowledge means for a typical 50.62 month old child. There was no significant main effect for intervention, $F(1, 20) = 4.24$, $p = .05$, no significant main effect of time, $F(1, 20) = .19$, $p = .66$, and no significant interaction of intervention x time $F(1, 20) = .27$, $p = .61$.

Figure 6

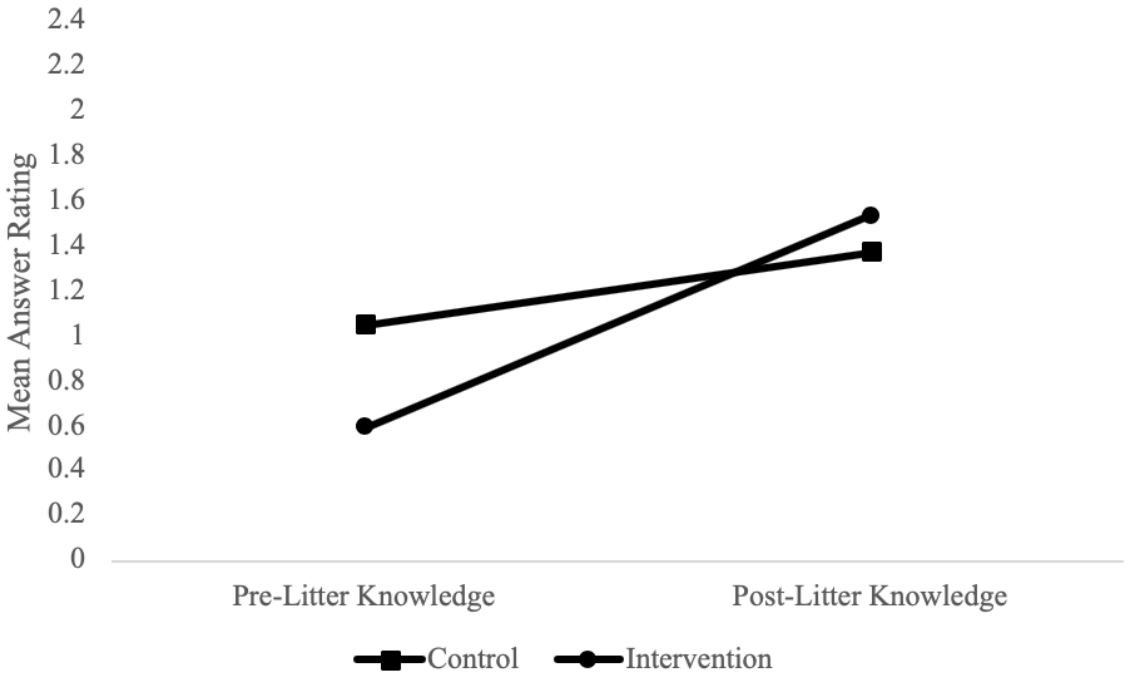
Mixed model ANCOVA for water question



Note. Pre-test and post-test means with regards to age for the question "What is one way that you can save water?". The figures represent knowledge means for a typical 50.62 month old child. There was no significant main effect for intervention, $F(1, 20) = .48$, $p = .50$, no significant main effect of time, $F(1, 20) = .11$, $p = .74$, and no significant interaction of intervention x time $F(1, 20) = .00$, $p = .97$.

Figure 7

Mixed model ANCOVA for litter question



Note. Pre-test and post-test means with regards to age for the question "Why is it bad to litter?". The figures represent knowledge means for a typical 50.62 month old child. There was no significant main effect for intervention, $F(1, 20) = .10$, $p = .75$, no significant main effect of time, $F(1, 20) = .35$, $p = .56$, and no significant interaction of intervention x time $F(1, 20) = .89$, $p = .36$.

Appendix A

Environmental Education Program Links

1) Recycling Lesson: https://youtu.be/jhL2RAGvBd4
2) Tree Lesson: https://youtu.be/nU-_P0pFuto
3) Water Lesson: https://youtu.be/hqa2XFsxQRI
4) Bee Lesson: https://youtu.be/gUFo0n-kRfE
5) Litter Lesson: https://youtu.be/H-7ZA2F00V8
6) Review Lesson: https://youtu.be/TCl2MUzC8SM

Appendix B

Pre- and Post-test Questionnaire With Photos

Note to Teacher/Survey Administrator: Read each question slowly and clearly using an engaging but neutral voice so as not to emphasize or encourage one response over another for each question. If the child is not sure, you can repeat the question as many times until they choose one. Put a check mark next to the statement that they choose, and whether it's a lot like the child or only a little like the child.

Hello [child's name]! Can I ask you some questions about the environment? [if answer is yes, ask questions] . I'm going to tell you TWO (show the #2 with your fingers) different descriptions that go with two different pictures. I want you to pick the one description that you feel is most like you. There are no right or wrong answers!

1. Some children like to leave the water running when they brush their teeth, but other children always turn the water off while brushing their teeth.

Which one do you feel like is more like you?

[Child chooses which one — can say or point to picture]

Do you feel like that is a lot like you or only a little like you?

☐ A Lot ☐ A Little ☐ A Little ☐ A Lot

2. Some children use both sides of their paper when they draw or write but other children only use one side of their paper when they draw or write.

Which one do you feel like is more like you?

[Child chooses which one — can say or point to picture]

Do you feel like that is a lot like you or only a little like you?

☐ A Lot ☐ A Little ☐ A Little ☐ A Lot

3. Some children think we should recycle things but other children think we should throw things away when we're done with them.

Which one do you feel like is more like you?

[Child chooses which one — can say or point to picture]

Do you feel like that is a lot like you or only a little like you?

☐ A Lot ☐ A Little ☐ A Little ☐ A Lot

4. Some children like to look at plants and bugs outside but never bring them home but other children like to bring home plants and bugs they find outside.

Which one do you feel like is more like you?

[Child chooses which one — can say or point to picture]

Do you feel like that is a lot like you or only a little like you?

☐ A Lot ☐ A Little ☐ A Little ☐ A Lot

5. Some children think people and animals are both important but other children think animals aren't important.

Which one do you feel like is more like you?

[Child chooses which one — can say or point to picture]

Do you feel like that is a lot like you or only a little like you?

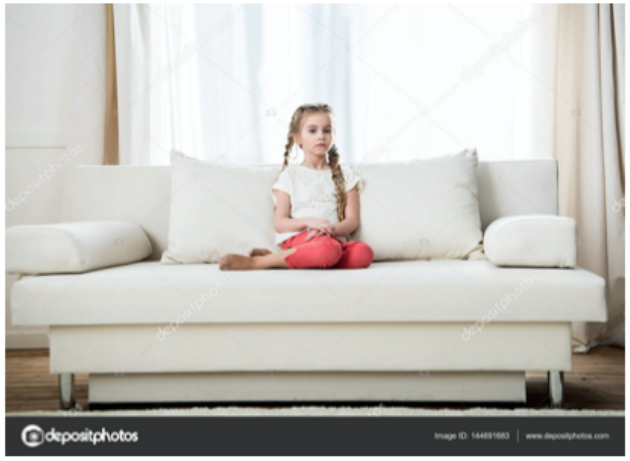
☐ A Lot ☐ A Little ☐ A Little ☐ A Lot

6. Some children don't like to camp or play outdoors but other children like to go camping or play outdoors.

Which one do you feel like is more like you?

[Child chooses which one — can say or point to picture]

Do you feel like that is a lot like you or only a little like you?



☐ A Lot ☐ A Little ☐ A Little ☐ A Lot

7. Some children give toys to other children or reuse them when they don't play with them anymore but other children throw away toys when they don't play with them anymore.

Which one do you feel like is more like you?

[Child chooses which one — can say or point to picture]

Do you feel like that is a lot like you or only a little like you?

☐ A Lot ☐ A Little ☐ A Little ☐ A Lot

8. Some children don't like to pick up smelly trash and throw it away but other children like to pick up trash and throw it away.

Which one do you feel like is more like you?

[Child chooses which one — can say or point to picture]

Do you feel like that is a lot like you or only a little like you?

☐ A Lot ☐ A Little ☐ A Little ☐ A Lot

9. Some children sort their bottles and cans and recycle them **but** other children don't sort their bottles and cans.

Which one do you feel like is more like you?

[Child chooses which one — can say or point to picture]

Do you feel like that is a lot like you or only a little like you?

☐ A Lot ☐ A Little ☐ A Little ☐ A Lot

10. Some children think that wild animals need protection but other children think we should put houses on land where wild animals live.

Which one do you feel like is more like you?

[Child chooses which one — can say or point to picture]

Do you feel like that is a lot like you or only a little like you?

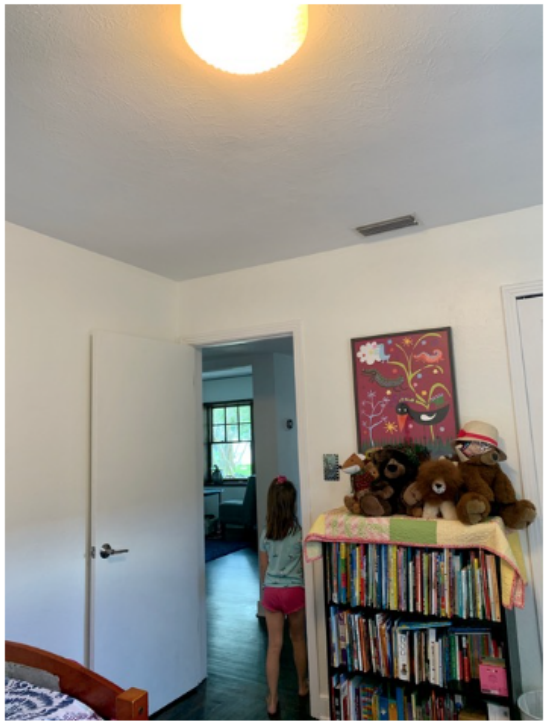
☐ A Lot ☐ A Little ☐ A Little ☐ A Lot

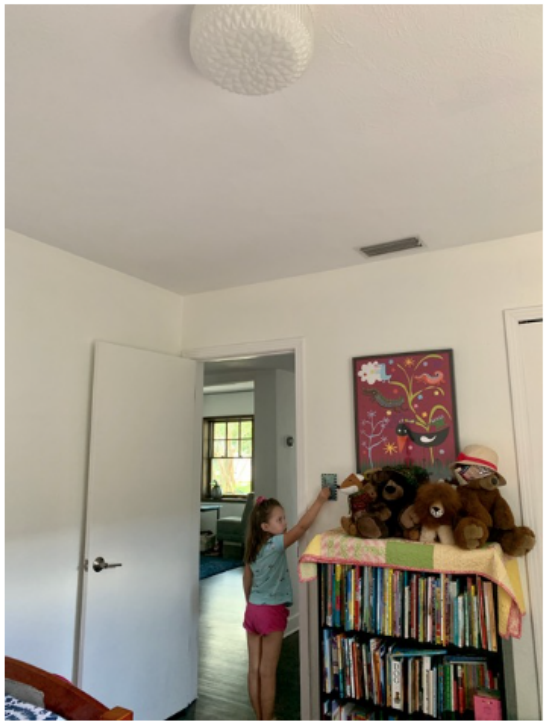
11. Some children leave the lights on when they leave a room but other children turn off the lights when they leave a room.

Which one do you feel like is more like you?

[Child chooses which one — can say or point to picture]

Do you feel like that is a lot like you or only a little like you?





☐ A Lot ☐ A Little ☐ A Little ☐ A Lot

Here are some questions that are a little different!

1. What is an item that you can recycle?
2. Why are bees important?
3. What is one reason that trees are important?
4. What is one way that you can save water?
5. Why is it bad to litter?

Appendix C

Coding Key for Knowledge Questions

How to code knowledge narratives: use just 0, 1, 2, 3

Examples are from question **"Why are bees important?"**

- **Don't assume that the child knows something because their statement might have hinted at it.**

0 = doesn't know answer, gives answer that is not correct.

Example: "bite"; "because they bite you"; "I don't know"; "because they're not nice"; "because they have they're bad bugs they're scary bugs"

1 = says a word or phrase that is relevant to the question but incomplete. Typically a score of 1 will be a one or two word response: honey, flowers, pollen. Does not explain reason for answer, and the description of the topic may only be about the physical aspects of subject in question. *.not important. Mooses hurt you. They live in Alaska."; "because they want to get in my yard. And sometimes they want to get in the park and and um the flew that monster that water"; "bees important. The bees love me"*

2 = elaborates on relevant word or phrase in an answer that almost completes the question but may be incomplete; may provide an egocentric answer/explanation that is relevant only for the individual (e.g. "Tree are important because I like to climb them").

Example: "bees honey they come from the bingsit and flowers"; "because they have to stay in a hive so we don't get a booboo from them. So we don't get a booboo on peoples fingers"

3 = factual response to question, and with a full explanation of the answer. Explanation is relevant beyond child's personal experience.

Example: "Because they make honey"; "bees bees bees they make honey"; "because they have to make honey!"; "because they help grow our food"